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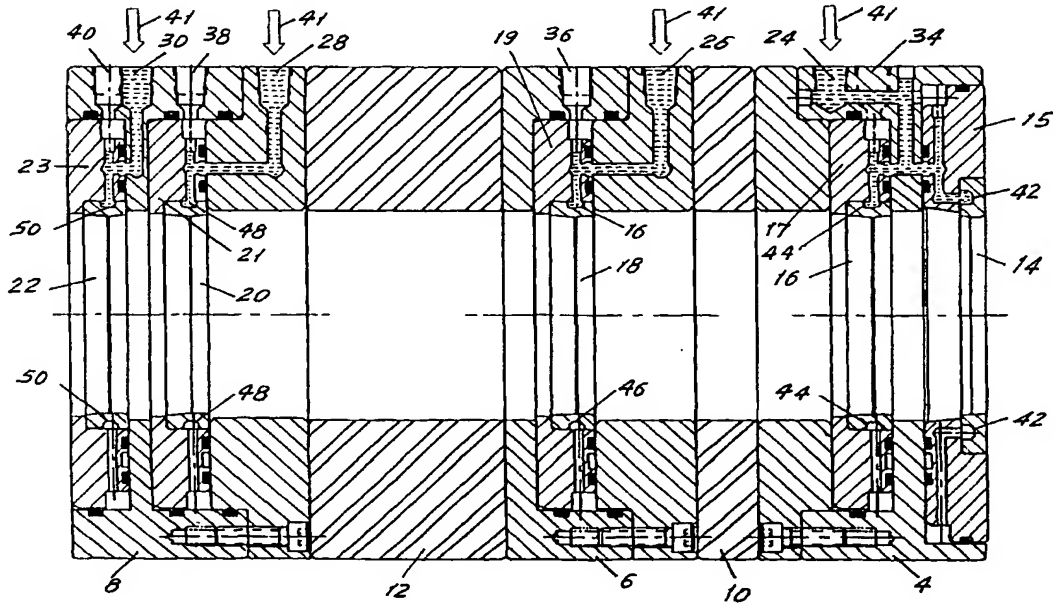
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: INTERNALLY COOLED TOOL PACK



(57) Abstract: A can forming tool pack (2) includes internally cooled die modules (4, 6, 8). Each die module includes at least one die nib (14, 16, 18, 20, 22) held in a case. Fluid cooling medium is supplied to multiple inlets (24, 26, 28, 30) provided circumferentially in each case. The cooling fluid is channeled from the inlets through clearances (42, 44, 46, 48, 50) between an outer surface of the die nib and the case to cool the die nib. Outlets (34, 36, 38, 40) are spaced circumferentially around the case to return the cooling fluid to the medium supply.

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INTERNALLY COOLED TOOL PACK

BACKGROUND OF THE INVENTION

1. Field of the Invention:

The present invention relates generally to can manufacturing tool pack assemblies that have drawing and ironing dies for reforming a cup into a container body, and more specifically to such a tool pack assembly that is internally cooled.

2. Brief Description of the Related Art:

Can forming dies are used to form the bodies of metal cans or containers. The description herein is particularly concerned with forming two piece metal containers. A shallow metal cup is driven into the dies by a punch to form the body of the can. The dies generally are provided in tool packs in which a series of progressively narrower die nibs are arranged to progressively draw and iron the metal cup into a container of the desired shape and thickness. An example of a conventional set of drawing and ironing dies in a tool pack is shown in U.S. Patent No. 4,173,882 issued to Lee, Jr. on November 13, 1979, the entire disclosure of which is incorporated herein by reference. Each die is included in a respective die module.

Die tool packs used in commercial can manufacturing conventionally use cooling fluids applied to the exterior of the die pack to maintain or reduce operational temperatures of the dies. In certain can forming applications, however, it is desirable to avoid the use of external cooling fluids. For example, external cooling fluids may contaminate the container surfaces, which requires costly and environmentally undesirable post-formation cleaning processes.

SUMMARY OF THE INVENTION

The present invention overcomes the disadvantages of the prior art, such as those noted above, by providing an internally cooled modular die tool pack assembly that does not require the use of cooling fluid applied to the exterior of the tool pack. Instead, the temperature of the tool pack is controlled by forcing a fluid, particularly a liquid, with desirable heat transfer properties around the die nibs through special die cavities and heat is transferred by conduction. The external temperature of each die nib can be monitored continuously at the respective die module, and the fluid medium temperature can be adjusted automatically to maintain acceptable die temperatures.

The fluid medium is supplied to the tool pack by a temperature control unit, and is delivered to the die modules by a series of pipes, fittings, and hoses. Fluid medium flows through porting in each module and its die where the fluid is directed circumferentially around the outer surface of the die nibs. Preferably, multiple porting in each die is circumferentially symmetrical, with alternating inlet and outlet ports to distribute the fluid medium uniformly around each die nib. The multiple fluid inlet and outlet design with symmetrical porting assures that all of the die nib temperatures remain substantially uniform, and also minimizes temperature gradients around the die. In a preferred embodiment, four inlet ports and four outlet ports are provided with inlet and outlet ports alternating at 45° apart. But the number and placements of ports can be altered to address specific temperature control requirements.

Other features and advantages of the present invention will become apparent from the following detailed description which refers to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an axial cross section of an internally cooled modular tool pack

assembly according to the present invention.

Fig. 2 is the axial cross section of Fig. 1 showing fluid cooling medium pathways flowing into the assembly.

Fig. 3 is the axial cross section of Fig. 1 showing fluid cooling medium pathways flowing out of the assembly.

Fig. 4 is a transverse cross section of a drawing and ironing die showing cooling fluid pathways in the die according to the present invention.

Fig. 5 is a cut away view of the drawing and ironing die taken along the line V-V of Fig. 4 .

DETAILED DESCRIPTION OF AN EMBODIMENT OF THE INVENTION

Fig. 1 shows an internally cooled modular die tool pack assembly **2** according to the present invention in an axial cross section. The assembly includes three annular die modules **4**, **6**, and **8** in sequence, with adjacent modules separated by spacers **10** and **12**. The first die module **4** includes an annular redraw die nib **14** followed by a first annular ironing die nib **16**. The next die module **6** includes a second annular ironing die nib **18**. The final die module **8** includes annular die nibs **20** and **22**. Die nibs **14**, **16**, **18**, **20**, and **22** are held in die cases **15**, **17**, **19**, **21**, and **23**, respectively.

Referring also to Figs. 2-5, each of the die modules **4**, **6**, and **8** has at least one inlet port and at least one outlet port for cooling medium. When multiple inlet and outlet ports are utilized, the ports preferably are arranged alternately and symmetrically around each die module.

Referring more specifically to Fig. 2, the first die module **4** is provided with an inlet port **24**, the second module **6** is provided with inlet port **26**, and the third module **8** has inlet ports **28** and **30**. Similarly, as shown in Fig. 3, die module **4** is provided with an outlet port **34**, module **6** is provided with outlet port **36**, and module **8** has outlet ports **38** and **40**, from which cooling medium exits

the tool pack assembly.

Fluid cooling medium provided by a conventional temperature control unit **39** flows through conduits **43** (Fig. 1) into the die modules through the inlet ports as shown by the directional arrows **41** of Fig. 2. Passages machined into each die module and through the cases direct the cooling medium to channels **42, 44, 46, 48,** and **50** formed in outer walls of die nibs **14, 16, 18, 20,** and **22** respectively.

The temperature control unit **39** may control both the rate of flow to each conduit **43** and inlet port at **41** and the respective temperature at each conduit and inlet port independently of the other conduits and inlet ports to accommodate and control the temperatures at the various die modules, since each module may be subject to a different respective heat load. After circulating partially circumferentially around each die, the cooling medium flows out of the die modules as shown by the directional arrows **43** of Fig. 3.

Thus, cooling medium flows through the channels in direct contact with a radially outer surface of each of the die nibs, drawing off heat that is generated in the die nibs during can drawing and ironing. Generally, the cooling medium passing around the die nibs absorbs heat and cools the die nib to maintain a desired temperature in each die nib. The fluid may also be heated to warm the die nibs, for example at machine startup. This may be desirable to minimize thermal expansion effects and improve the drawing, ironing and can stripping processes.

Referring to Figs. 4 and 5, die nib **16** and die case **17** are shown to illustrate the symmetrically spaced inlets and outlets for providing cooling media to die nib **16**. Cooling medium enters case inlets **52, 54, 56,** and **58,** flows radially in through case **17,** and circumferentially along channel **44** formed around one quarter of the outer circumference of die **17**. Cooling medium exits the die module through outlets **60, 62, 64,** and **66**. Plugs **68, 70, 72,** and **74** seal off the machined outer ends of inlets **52, 54, 56,** and **58,** respectively. Only one

passage of cooling medium from inlet 52 circumferentially in both directions to outlets **60, 66** is illustrated. The other inlets and outlets for that die module are arranged in the same manner. As a result, an inlet and the adjacent outlet are 45° apart. Die nibs **14, 18, 20,** and **22** are cooled by a similar arrangement of symmetrically spaced inlets and outlets.

Advantageously, the symmetrical spacing of the case inlets and outlets provides for even cooling of the die nibs, thereby insuring that die nib temperatures remain uniform, and minimizing circumferential temperature gradients. The external temperature of each die nib can be monitored, either by temperature measurement thermometers **80** at each module or by monitoring the temperature of the exiting cooling medium, and temperature adjustments can be made as necessary.

Although the present invention has been described in relation to a particular embodiment thereof, many other variations and modifications and other uses will become apparent to those skilled in the art. It is preferred, therefore, that the present invention be limited not by the specific disclosure herein, but only by the appended claims.

WHAT IS CLAIMED IS:

1. A die module for a drawing and ironing assembly, the module comprising:

a die nib having an inner side for contacting an object for drawing or ironing the object, and the nib having an outer side;

a case surrounding the die nib;

a plurality of inlets spaced around the case around the nib, the inlets for supplying fluid cooling medium into the case;

a plurality of outlets for cooling medium flowing out of the case; and

a respective fluid path between at least one of the inlets and at least one of the outlets and at the outer side of the nib for carrying the cooling medium in direct contact with the die nib.

2. The die module of claim 1, wherein the fluid path comprises a clearance between the case and the die nib.

3. The die module of claim 2, wherein the clearance is a circumferential channel formed on the outer side of the die nib.

4. The die module of claim 1, wherein the inlets are spaced symmetrically around the case.

5. The die module of claim 1, wherein the outlets are spaced symmetrically around the case.

6. The die module of claim 5, wherein the inlets are spaced symmetrically around the case.

7. The die module of claim 6, wherein each inlet is connected by the respective path with one outlet and each path extends over a respective part of the circumference of the nib.

8. A can forming die assembly including a plurality of the die modules of claim 1, wherein the modules are arrayed in a linear sequence for enabling a punch to pass through the respective dies in the modules in sequence.

9. The assembly of claim 8, wherein each fluid path comprises a clearance between the case and the respective die nib.

10. The assembly of claim 9, wherein the clearance is a circumferential channel formed on the outer side of the die nib.

11. The assembly of claim 8, wherein the inlets are spaced symmetrically around the case.

12. The assembly of claim 8, wherein the outlets are spaced symmetrically around the case.

13. The assembly of claim 12, wherein the inlets are spaced symmetrically around the case.

14. The assembly of claim 13, wherein each inlet is connected by the respective path with one outlet and each path extends over a respective part of the circumference of the nib.

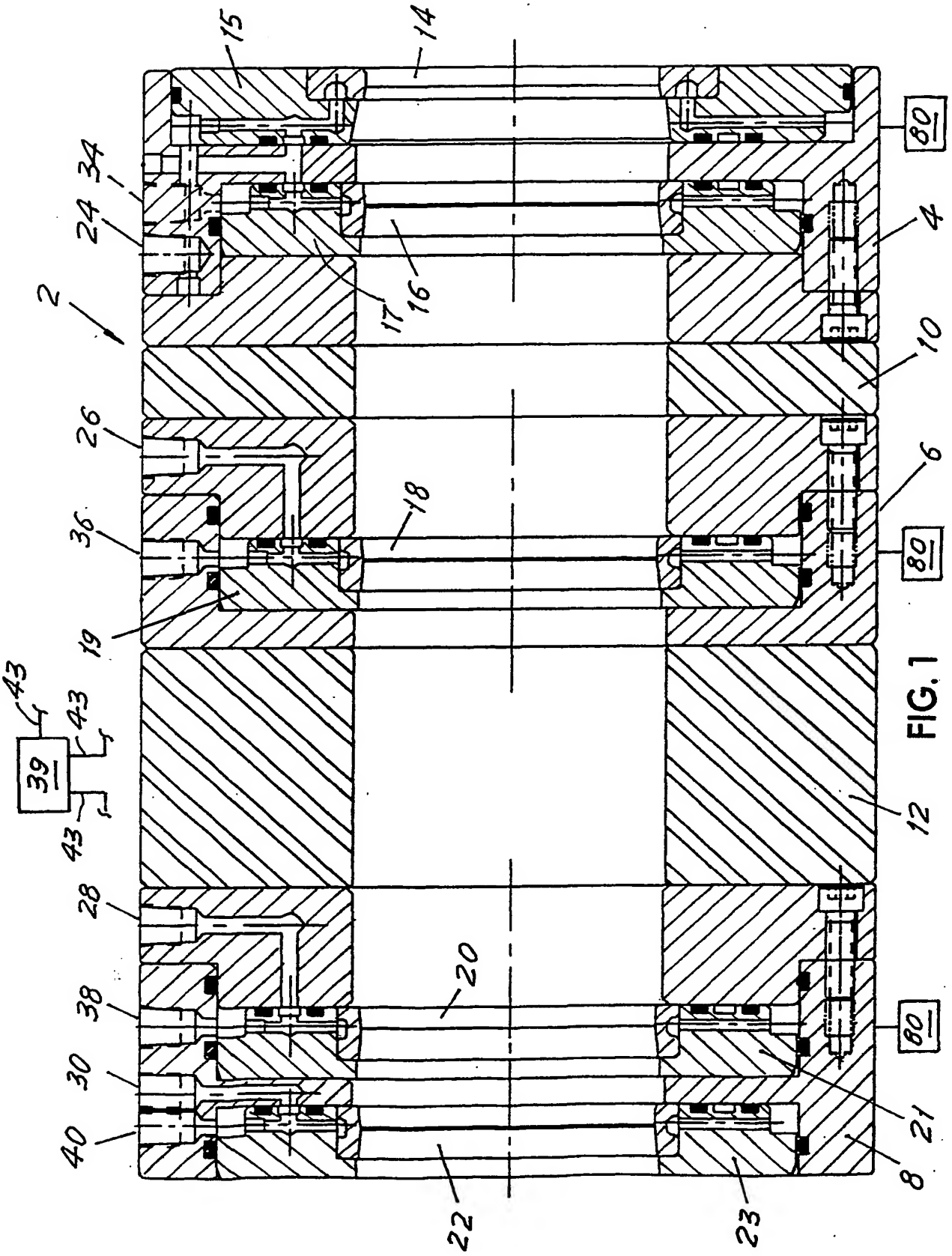

FIG. 1

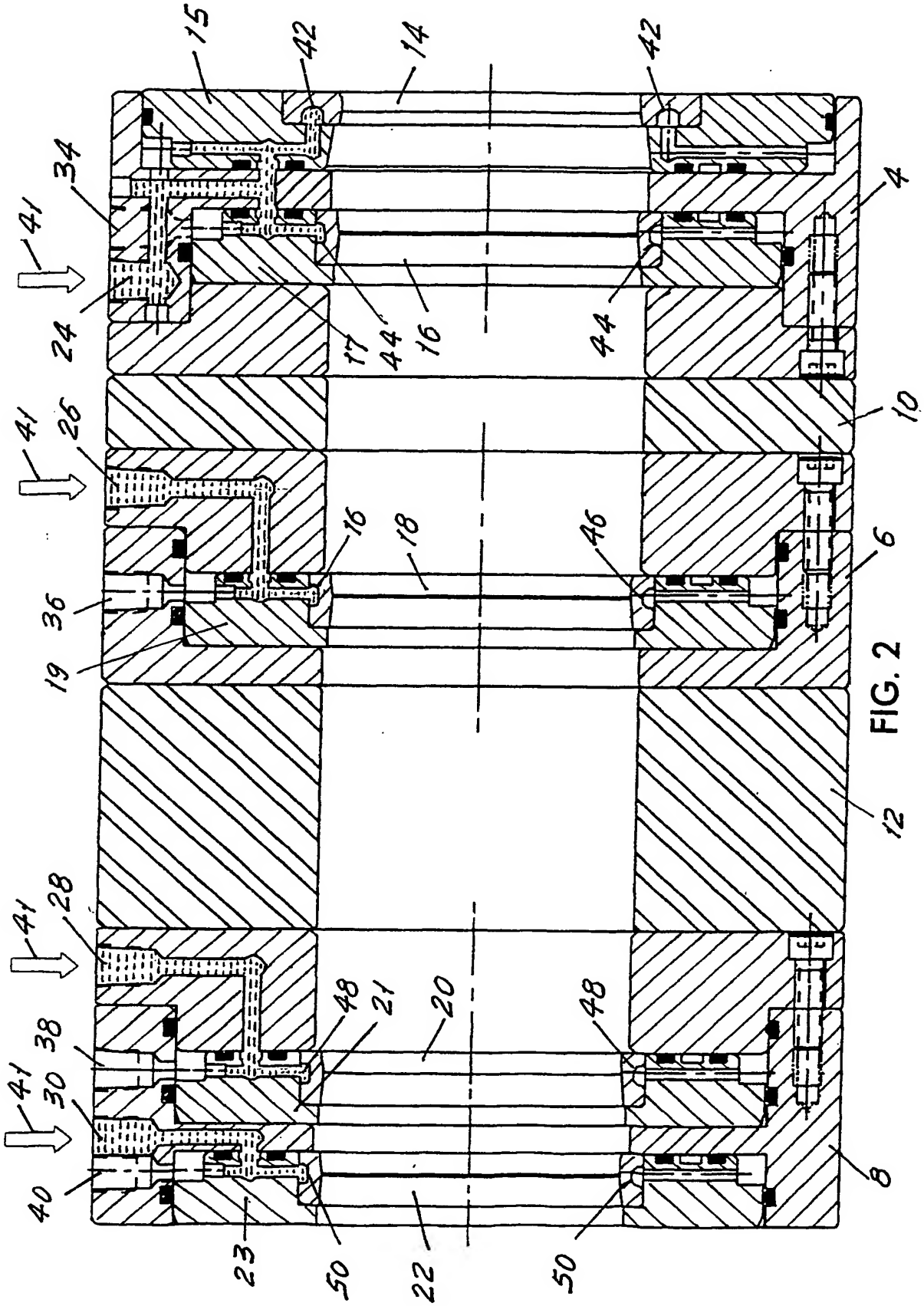

FIG. 2

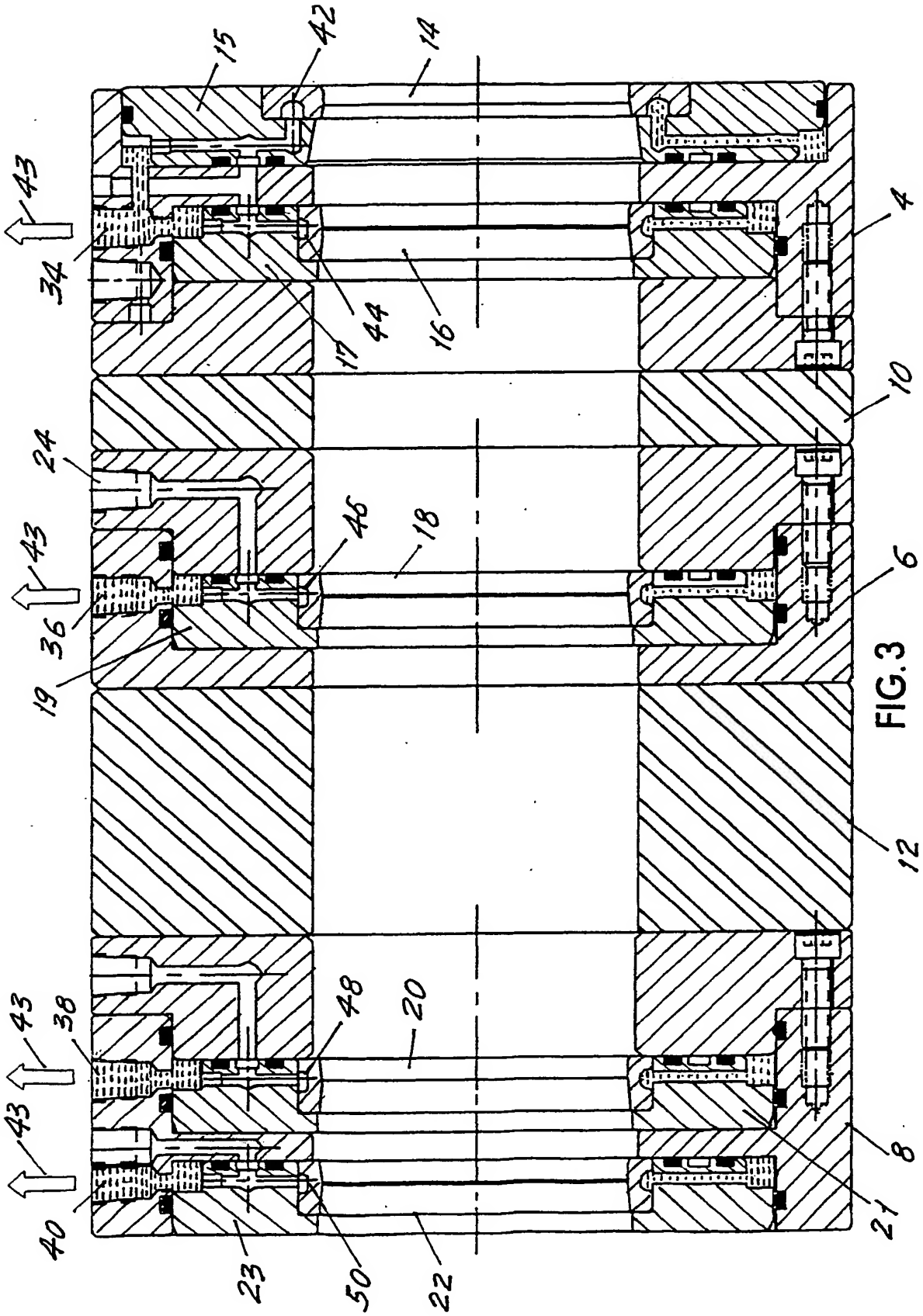

FIG.3

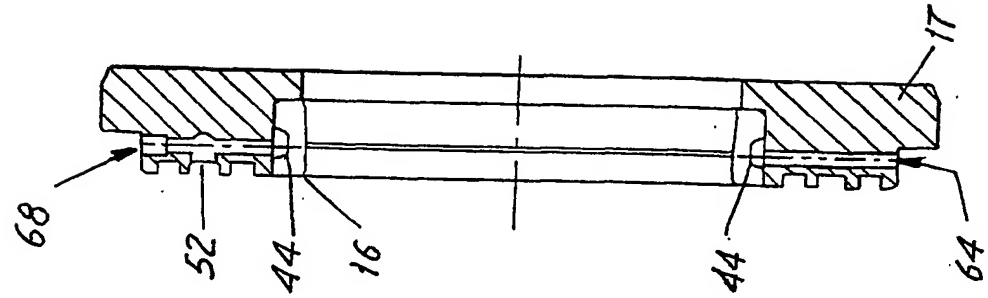

FIG. 5

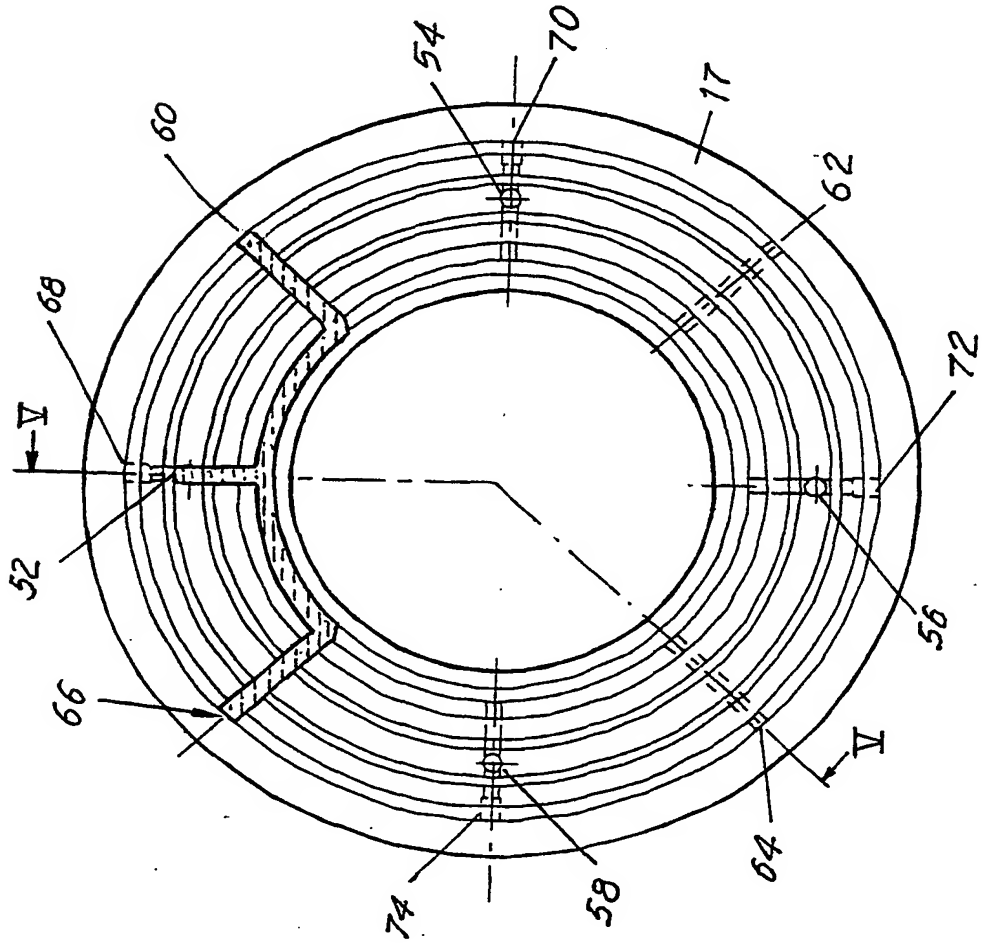

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US02/34896

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : B21D 22/28
US CL : 72/342.3

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 72/342.3, 342.4, 349

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 883,695 A (CANDA) 07 April 1908 (07.04.1908), whole doc.	
Y	US 4,502,313 A (PHALIN et al.) 05 March 1985 (05.03.1985), Figure 3, col.7, line 48 to col. 8, line 47	1-14
A	US 6,263,718 B1 (BUSE et al.) 24 July 2001 (24.07.2001) Figure 11, col. 2, lines 65-67	1-14

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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